

Question 8**Problem:**

A ball is launched vertically upward, and its height in meters at time t seconds is modeled by:

$$h(t) = -5t^2 + 20t + 1$$

- (a) Find all critical points of the function $h(t)$.
- (b) Use the First Derivative Test to classify each critical point.
- (c) What is the maximum height reached by the ball and at what time?

Question 8 - Solution

(a) Find critical points:

Take the derivative:

$$h'(t) = -10t + 20$$

Set $h'(t) = 0$:

$$-10t + 20 = 0 \Rightarrow t = 2$$

Critical point: $t = 2$

(b) First Derivative Test:

For $t < 2$: pick $t = 1$, $h'(1) = -10(1) + 20 = 10 > 0$ For $t > 2$: pick $t = 3$, $h'(3) = -10(3) + 20 = -10 < 0$ Since $h'(t)$ changes from positive to negative at $t = 2$, this is a local maximum.

(c) Maximum Height:

Substitute $t = 2$ into $h(t)$:

$$h(2) = -5(4) + 20(2) + 1 = -20 + 40 + 1 = 21$$

Answer: The maximum height is 21 meters, reached at $t = 2$ seconds.

Graph of the Trajectory:

